

[fol. 177]

## APPENDIX B

Description of Exhibits Introduced at Television Hearing in Docket Nos.  
8736, 8975, 9175 and 8976

Exhibit Number	Description	Offered by
201	Notice of Further Proposed Rule-Making (FCC 49-948)	FCC
202	Amendments to above Notice: (FCC 49-1044) (FCC 49-1145) (FCC 49-1197) (FCC 49-1223)	FCC
203	"Comments on the Proposed Allocation of Television Broadcast Services." (Volume IV)	Joint Technical Advisory Committee (JTAC)
204	"Report of the Color Television Committee of the RMA Engineering Department."	Radio Manufacturers Association (RMA)
205	"Membership of Radio Manufacturers Association."	RMA
206	"Comments of Radio Corporation of America."	RCA
207	"Engineering Statement Supplemental to Comments of Radio Corporation of America."	RCA
208	Copy of letter dated September 13, 1949, addressed to Paul A. Walker, Acting Chairman, FCC by C. B. Jolliffe, replying to FCC letter of August 26, 1949.	RCA
209	Booklet consisting of 25 pages bearing the heading "A Six-Megacycle Compatible High-Definition Color Television System."	RCA
210	Loose-leaf book containing tabs numbered 1-19, inclusive, entitled "Exhibits—Columbia Broadcasting System, Inc."	CBS
211	One page containing drawings illustrating use of "Color Cameras," "Color Receivers on Color Converters," and "Color Converter Only."	CBS
[fol. 178]		
212	Chart bearing the title "Relative Registration Problems in Color Television."	CBS
213	Photograph of 2 pictures, illustrating "Low Contrast" and "Normal Contrast."	CBS
214	Card containing 2 sets of pictures showing contrasts.	CBS
215	Graph showing "Amplitude Response—Vs—Freq. of Low Pass Amplifier."	CBS
216	Diagram of CBS disc-type receiver.	CBS
217	"Parts list for CBS Scanning Adapters and Color Converters."	CBS
218	"Schedule of Tests of CBS Color Television, October 6, 1949, Hotel Carlton, Washington, D. C."	CBS
219	"Local Video Facilities Provided by	CBS

<sup>1</sup> See Exhibit No. 287 and footnote 5.

<sup>2</sup> Item 20 added on October 24, 1949.

<sup>3</sup> Only one copy available for the record. No distribution.

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
220	the Telephone Company in Connection with the CBS Demonstration . . . "Camera Viewing Distances World Series Game, Thursday, October 6th, 1949."	Allen B. DuMont Laboratories, Inc. (DuMont)
221	"Physical Conditions of CBS Pickup at Woodrow Wilson High School, Washington, D. C., During Color Television Demonstration Before the FCC . . . October 7, 1949."	CBS
222	Schedule of Demonstration of RCA Color Television System—October 10, 1949 at Washington Hotel and Wardman Park Hotel in Washington, D. C.	RCA
[fol. 179]		
223	Chart showing transmission route from WNBW, Wardman Park Hotel to Hotel Washington.	RCA
224	Drawing showing distribution of primary colors by dichoric mirrors.	RCA
225	Forty-five (45) drawings for CBS color converter.	CBS
226	Copy of form of license agreement used by CBS in licensing manufacturers of color television receivers.	CBS
227	Copy of form of license agreement used by CBS in licensing manufacturers of color television transmitter studio apparatus.	CBS
228	Photograph of color converter.	CBS
229	Photograph of bolts and frame used with color converter.	CBS
230	Four-page pamphlet describing motors of Eastern Air Devices, Inc.	CBS
231	"The Geer Color Television Receiver Tube." (16 unnumbered pages).	Dr. Charles Willard Geer
232	One page containing four photographs showing "Front View of C.T.I." "Bakeout Ovens—Tube Laboratory," etc.	C.T.I.
233	One page containing three photographs showing "Racks of Equipment," etc.	CTI
234	One page containing four photographs showing "Tube Laboratory," "Studio," etc.	CTI
[fol. 180]		
235	One page containing three photographs of a color receiver showing "Back View," "Receiver Lens Unit," etc.	CTI
236	One page containing two photographs of a color camera showing "A Standard Monochrome Camera Converted for Color Pick-Up," and "Camera Lens Assembly"	CTI
237	One page containing three photographs showing "7 inch C.T.I. Trichrome Projection Picture Tube."	CTI
238	Gray-covered book entitled "Written Comments of Color Television Incorporated."	CTI

\* Contains affidavit of Arthur S. Mathews which was not offered as part of exhibit.

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
239	"CBS Color System Video Frequency Response Characteristics."	CBS
240	One page entitled "Scanning Sequence—Block Diagram."	CTI
241	One page diagram entitled "Color Transmitter."	CTI
242	One page diagram entitled "Color Receiver."	CTI
243	One page diagram entitled "Modified RMA Sync Pattern for Single Shift Color Scanning."	CTI
244	One page diagram entitled "Color Pulse Separator."	CTI
245	One page diagram entitled "Receiver Color Pulse Separator."	CTI
246	One page containing photographs entitled "Synchronising Waveform photographs (Unretouched)."	CTI
247	One page diagram entitled "CTI Color Television System."	CTI
[fol. 181]		
248	One page diagram entitled "Camera Scanning Generator."	CTI
249	One page diagram entitled "Color Slide Scanner."	CTI
250	One page diagram entitled "30 frame continuous film pickup on recorder."	CTI
251	One page diagram entitled "CTI Color Film Pickup System."	CTI
252	One page diagram entitled "CTI Color Television Receiver—Block Diagram."	CTI
253	One page diagram entitled "CTI Color Television Receiver—420 Volt Regulated Power Supply."	CTI
254	One page diagram entitled "CTI Color Television Receiver—Circuit Diagram R.F. High Voltage Power Supply."	CTI
255	One page diagram entitled "CTI Color Television Receiver—Video & Audio Circuits."	CTI
256	One page diagram entitled "CTI Color Television Receiver—Sync & Deflection Circuits."	CTI
257	One page diagram entitled "Lens & Tube Mounting Assembly."	CTI
258	One page diagram entitled "7" Tube Tri-lens Mounting."	CTI
259	One page drawing entitled "Table Model Color Receiver."	CTI
260	One page drawing entitled "Color Converter."	CTI
261	One page diagram entitled "CTI Direct View Color Receiver with Selective color line tube."	CTI
[fol. 182]		
262	One page diagram entitled "Color Shift Unit Block Diagram."	CTI
263	One page diagram entitled "Waveforms In Color Shift Unit For Field No. 1."	CTI

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
264	One page diagram entitled "CTI Color Shift Timing Unit."	CTI
265	One page diagram entitled "Transmitter Color Sync Injector—Block Diagram."	CTI
266	One page diagram entitled "Transmitter Color Sync Injector—Circuit Waveforms."	CTI
267	One mimeographed page entitled "Rules for Color Sequence Phase Shift."	CTI
268	Pamphlet of the Underwriters' Laboratories, Inc., entitled "Standard for Power-Operated Radio Receiving Appliances."	CBS
269	Forty-six (46) drawings for a combination black and white color receiver, table model.	CBS
270	One page drawing entitled "Color Television Systems."	CTI
271	One page chart entitled "Television Channels."	CTI
272	One page containing chart entitled "Video Waveforms for Vertical Lines."	CTI
273	One page containing chart entitled "Effect of distortion of color wave proposed by RCA."	CTI
274	Two pages entitled "Technical Qualifications of David Beach Smith."	PHILCO
[fol. 183]		
275	Booklet consisting of 15 pages entitled "Statement on Behalf of Philco Corporation and Philco Television Broadcasting Corporation by David B. Smith."	PHILCO
276	Green folder entitled "Direct Testimony of Dr. T. T. Goldsmith," Volume IV, Section A.	DuMONT
277	Mimeographed booklet of 35 pages entitled "Comments in Opposition to Proposals filed with the F. C. C. August 26, 1949." Volume III.	DuMONT
278	Five pages entitled "Brief Report on the conversion to Color of an existing Hampshire Television Receiver."	DuMONT
279	Photographs of Hampshire Television Receiver with color converter in position.	DuMONT
280	Three mimeographed pages entitled "Reduction of Hum in DuMont Television Receiver for Purposes of Field Sequential Color Reception."	DuMONT
281	One mimeographed page entitled "Optical Performance of Demonstrated Receivers."	DuMONT
282	Five pages entitled "DuMont Price Estimates for Color Television Receivers."	DuMONT
283	Article in Saturday Evening Post entitled "Mr. Technicolor" by Frank J. Taylor. (10/22/49 issue.)	DuMONT
284	Copies of 3 identical letters sent by Wheeler & Wheeler to Counsel for RCA, CTI and CBS, dated 10/27/49.	RMA

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
285	One page containing letter dated November 2, 1949, to Edward K. Wheeler, Wheeler & Wheeler, from Richard S. Salant concerning Exhibits 216, 217, 225 and 269.	CBS
[fol. 184] 286	Copy of letter dated November 2, 1949 from Glen McDaniel to Edward K. Wheeler replying to letter of October 27, 1949.	RCA
287	29 mimeographed pages entitled "Final Report of RMA Color Television Committee #4."	RMA
288	11 pages entitled "A Petition Regarding a System for Television at UHF."	Raymond M. Wilmotte
289	29 pages and 21 diagrams and charts entitled "Frequency Modulation."	Wilmotte
290	One page map entitled "Figure 1B, Polycasting, Example of Allocation for typical midwestern areas."	Wilmotte
291	One page map entitled "Figure 2B, Polycasting, Example of Allocation between New York and Baltimore."	Wilmotte
292	Article in November 1949 issue of "Tele-Tech" entitled "Dr. Lee de Forest's Color Television System."	Lee de Forest
293	10 mimeographed pages and 2 pages containing 11 figures, entitled "Reduction of Interference in TV Broadcasting by the Use of Frequency Modulation, Project No. 22531, Part I."	FCC
[fol. 185] 294	Four mimeographed pages entitled "Notice of Program Material and Room Arrangements at Comparative Demonstration" (FCC 49-1524).	FCC
295	Description of facilities used during comparative demonstrations on November 21 and 22, 1949.	
296	Circuit diagram entitled "Automatic Scanning Adapter for Bendix Model 235 MI TV Receiver" and parts list.	FCC
[fol. 186] 297	Three mimeographed pages entitled "Color TV Comparative Demonstration—February 23, 1950.	FCC
298	One page diagram—"Receiver Set Up—CTI Demonstration—Hotel Statler—Washington, D. C.—February 20, 1950."	CTI
299	One page diagram—"Position of CTI Receivers—Laurel, Md. Laboratory."	CTI
299A	Statement of Donald K. Lippincott respecting transmitting and receiving equipment, receivers and receiver positions of CTI facilities at demonstrations of February 20 and 23, 1950."	CTI

<sup>5</sup> Substituted for report of RMA Committee #4 in RMA Exhibit No. 204.

<sup>6</sup> Exhibit number reserved during comparative demonstration on November 21, 1949.

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
300	Three mimeographed pages and 2 diagrams entitled "Transmitting and Receiving Facilities Used by Radio Corporation of America in the Comparative Tests, February 23, 1950."	RCA
301	"Description of CBS Transmitting and Receiving Facilities—Comparative Demonstration, February 23, 1950."	CBS
302	"Color TV Comparative Demonstration—FCC Laboratory, Laurel, Md., February 23, 1950—Observations of Picture Resolution."	FCC
303	Progress Report of December 30, 1949.	RCA
304	"Amendments to Written Comments, January 31, 1950."	RCA
305	Bulletin—"A 15 by 20-inch Projection Receiver for the RCA Color Television System."	RCA
306	Bulletin—"Synchronization for Color Dot Interlace in the RCA Color Television System."	RCA
307	Bulletin—"A Two-Color Direct-View Receiver for the RCA Color Television System."	RCA
308	Bulletin—"An Experimental UHF Television Tuner."	RCA
309	Bulletin—"A Three-Color Direct-View Receiver for the RCA Color Television System."	RCA
[fol. 187]		
310	Bulletin—"An Experimental Determination of the Sideband Distribution in the RCA Color Television System."	RCA
311	Bulletin—"A Study of Co-Channel and Adjacent Channel Interference of Television Signals, Part I."	RCA
312	Bulletin—"A Study of Co-Channel and Adjacent Channel Interference of Television Signals, Part II."	RCA
313	Bulletin—"An Experimental UHF Television Converter."	RCA
314	Bulletin—"Recent Developments in Color Synchronization in the RCA Color Television System."	RCA
315	Bulletin—"Colorimetric Analysis of RCA Color Television System."	RCA
316	Bulletin—"A Simplified Receiver for the RCA Color Television System."	RCA
317	"CBS Letter of December 20, 1949, to the Federal Communications Commission Outlining Proposed CBS Test Operations."	CBS
318	"Progress Report of Colombia Broadcasting System, Inc., Relating to Matters Covered by Commission Notice Issued November 22, 1949."	CBS
319	"Location of CBS Color Television Receivers November 22, 1949—February 23, 1950."	CBS
320	"Program Schedule—CBS Color Television Broadcasts—January 1 to February 1, 1950."	CBS

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
321	<sup>3</sup> /CBS Color Television Camera Operation Log (Smith, Kline & French Equipment) for the Period December 29, 1949 to February 1, 1950, Inclusive."	CBS
322	"Basic Features of the CBS Color Television System."	CBS
323	Chart—"AMA Interim Meeting, December 6-9, Baltimore-Washington Pickup."	CBS
[fol. 188]		
324	Diagram—"Seating Arrangement, National Guard Armory—AMA Interim Meeting, December 6-9, 1949, Baltimore-Washington Pickup."	CBS
325	Chart—"Atlanta Graduate Medical Assembly—Atlanta, Georgia—February 6-8, 1950."	CBS
326	"Summary of Hours of Special Transmissions over Stations WCBs-TV, WOR-TV, WOIC and WCAU-TV Covering Periods During Which Color Was Transmitted (November 22, 1949 to February 21, 1950)."	CBS
327	Letter dated November 3, 1949, addressed to Commissioner Edward M. Webster by Richard S. Salant.	CBS
328	Correspondence between W. R. G. Baker, National Television System Committee and Adrian Murphy, CBS concerning CBS representation on NTSC.	CBS
329	"Color Television Interference Tests."	CBS
330	"Conditions at Pickup and Receiving Locations During Color Television Demonstrations for AMA Interim Convention, December 6-9, 1949."	CBS
331	"Qualifications and Experience of Dr. Jack W. Dunlap."	CBS
332	"Doctors' reactions to color television at the American Medical Association Interim Convention—Washington, D. C., December 6-9, 1949."	CBS
332 <sup>7</sup>	12½-inch colored picture.	CBS
334 <sup>8</sup>	16-inch black-and-white picture.	CBS
335	"Letter of January 30, 1950 from Dr. Peter C. Goldmark to Various Parties Re Automatic Adapter." (3 enclosures attached.)	CBS
336	"Combination Color—Monochrome Television Receiver—Instructions."	CBS
[fol. 189]		
337	"CBS Color Receiver Home Service Notes."	CBS
338	"Modifications to Standard TV Recording Equipment for Black and White Operation with CBS Color Standards."	CBS
339	"Summary of Changes to be Made to Single Camera RCA Field Equipment for Use on CBS Color Standards."	CBS

<sup>7</sup> Only one copy available for the record. No distribution.<sup>8</sup> Only one copy available for the record. No distribution.

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
340	"Block diagram of single camera chain, using CBS and converted RCA field equipment, for CBS standards."	CBS
341	"Standards of Automatic Phasing Pulse with modification."	CBS
342 <sup>9</sup>	Two frames of technicolor film.	CBS
343	"Program. The Clinical Session of the American Medical Association Presents Color Television of Surgical Operations and Medical Clinics."	CBS
344	"Comparative Resolution of the Various Color Systems."	CBS
345-A <sup>10</sup>	Photograph, 525-line standard black and white resolution.	CBS
345-B <sup>11</sup>	Photograph, 4 megacycles, 405 lines, 144 fields, with crispening circuit.	CBS
[fol. 190]		
346	"A Study of Television Viewing Under Normal Home Conditions."	CBS
347	"Qualifications and Experience of Oscar Katz."	CBS
348	"Public Reaction to Color Television." (January 12-February 1, 1950.)	CBS
349	"Public reaction to Color Television." (February 13-21, 1950.)	CBS
350	Letter dated February 6, 1950 to Dr. John Riley from Edward G. Reeve.	CBS
351	Minutes of meeting between FCC and CBS Representatives Concerning Field Tests.	FCC
352	Drawing of Converter bearing identification number B5770.	Celomat
353	Drawing of housing with built in magnifying lens bearing identification number C5774.	Celomat
354	"Bell System Intercity Television Facilities Existing and Planned as of March 15, 1950."	AT&T
355	"Television Broadcasting Stations in Cities Connected by Bell System Video Channel Networks As of March 18, 1950."	AT&T
356	"Television Broadcasting Stations in Cities connected by Bell System Video Channel Networks—Periods of Network Connection each day for week starting March 12, 1950."	AT&T
357	"Data Requested to be Furnished by Frank Stanton."	CBS
358	"Estimated Distribution of Cumulative Television Set Production, June, 1950-June, 1954."	CBS
359	(Reserved for cost data concerning color TV program. Testimony of William R. McAndrew was substituted for exhibit. Vol. 41, p. 7723-7732.)	RCA

<sup>9</sup> Only one copy of each frame available for the record. No distribution.<sup>10</sup> Only one copy available for the record. No distribution.<sup>11</sup> Only one copy available for the record. No distribution.

[fol. 191]

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
360	"Hours of Local and Network Programming of Stations Carrying NBC Programs—February 1-7, 1950—Interconnected Stations."	RCA
361	"Comparison of Network and Local Programming CBS Affiliates—February 1-7, 1950—Interconnected Affiliates."	CBS
362	"Statement By The Western Union Telegraph Co." containing four appendices.	WU
363	"Scanning Process in RCA Dot Sequential Color Television System."	Jensen
364	"American Research Bureau—Special Report For Station WNBW."	RCA
365	"Special Report For Station WNBW—February 11, 1950."	RCA
366	Letter dated March 14, 1950 from Kenneth M. Gopen to Charles Colledge.	RCA
367	"Analysis of Mail Responses to NBC Color Television Tests."	RCA
368	"Additional Data on Co-channel and Adjacent-channel Interference of Television Signals."	RCA
369	"Summary of Results of Co-channel and Adjacent-channel Television Signal Interference Studies."	RCA
370	"Frequency Characteristic of the Transmitter of Television Station WNBW, Washington, D. C."	RCA
371	"Additional Data on Signal to Interference Ratios."	RCA
372	"Additional Data on Signal to Ambient Noise Ratios."	RCA
[fol. 192]		
373	"Additional Data on Signal to Receiver Noise Ratios."	RCA
374	"Additional Data on Transmission Irregularities."	RCA
375	"Additional information on effect of color sync and phasing signal on black and white receivers."	RCA
376	"Additional information on UHF television transmitters and receivers."	RCA
377	"Summary of field test activities with relation to Appendix A of the Commission's Notice of November 22, 1949."	RCA
378	"Studio equipment and costs for RCA color television system."	RCA
378-A	"Supplement to Exhibit No. 378."	RCA
379	"An analysis of the sampling principles of the RCA color television system."	RCA
380	"Estimated population served by radio relay by end of summer 1950."	RCA
381	"Population within estimated service areas of cities which could receive 4-megacycle network service by radio relay as of March 22, 1950."	RCA
382	"General description of receivers for the RCA color television system which employ the RCA direct-view tricolor kinescopes."	RCA

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
383	"RCA tri-color kinescope demonstration arrangements in NBC Studio A, Translux Bldg., Washington, D. C., April 6, 1950."	RCA
384	"Responses of RMA members to inquiry whether they had ever made experimental color television receivers."	RMA
[fol. 193]		
385	"Post-war RMA set production by model."	RMA
386	"Radio & Television Retailing in two parts—Part two, March 1950."	RMA
387	"Description of techniques and equipment employed in Part B of the color TV comparative demonstration February 23, 1950, at F.C.C. Laboratory near Laurel, Maryland."	FCC
388	"Statement of E. W. Chapin, Chief, Laboratory Division, Federal Communications Commission."	FCC
389	"Project No. 222912—March 23, 1950—Part I—Beat pattern effects in the RCA color television system as compared to standard monochrome."	FCC
390	"Television modulation systems, Project No. 22531, Part III, modification of existing black and white receivers to receive color television."	FCC
391	"Project No. 222912—April 5, 1950—Part II—Beat pattern effects in the CBS color television system."	FCC
392	"Color characteristics of the RCA tri-color kinescopes."	RCA
393	"Location of present and projected television stations." (Map)	CBS
394	"A statement of some television facts."	CBS
395	Complaint and affidavit of J. H. Ream in action entitled "Supreme Court; New York County—Columbia Broadcasting System, Inc., Plaintiff, against Columbia of New York, Inc., Defendant."	CBS
396	"Cost information for converting the studio equipment of a monochrome station to color using CBS color standards."	CBS
[fol. 194]		
397	"B. & W. television receiver brightness survey."	CBS
398	"Fig. 1—Contrast discrimination versus brightness."	CBS
399	Gray covered book containing copies of letters sent by Webster—Chicago Corporation on November 21, 1949, to manufacturers of television receivers.	CBS
400 <sup>12</sup>	Six separate pictures of console television receivers.	RCA
401	Diagram—"Receiver for CBS color-TV horizontal interlace tests."	CBS
402	"Principal patented elements of CBS color television system as demonstrated to FCC and used during tests under FCC Notice of November 22, 1949."	CBS

<sup>12</sup> Only one set available for record. No distribution.

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
403	"Total licensing fees which may be payable by manufacturer of combination standard black and white and CBS color receiver, assuming licenses from RCA and Hazeltine."	CBS
404	"License Agreement between Allen B. DuMont Laboratories, Inc., and _____ For Cathode Ray Tubes."	Dumont
405	Gray covered book containing "Additional Color Television Exhibits."	Dumont
406	"Demonstration of CBS television for the Federal Communications Commission." (April 26, 1950—N. Y. City)	CBS
407	Three photographs of new CBS industrial color television camera and control unit.	CBS
408	"Time availability and cost of apparatus necessary for color television."	RMA
[fol. 195]		
409	"Brightness measurements on Commercial black-and-white television receivers."	Dumont
410	"License agreement between Radio Corporation of America and for commercial radio apparatus." (1937)	RCA
411	"License agreement between Radio Corporation of America and for radio broadcast receiving sets and electrical phonographs." (1948)	RCA
412	List—"Patents pertaining to television standards recommended by RMA owned by RCA and/or under which it has the right to grant, and has granted, licenses to others."	FCC
413	Letter dated September 10, 1938, from Bond Geddes to Chairman, FCC enclosing proposed TV standards T-101 to T-114.	FCC
414	List—"Video patents (excluding electron tubes) owned by Radio Corporation of America and being used by RCA or its licensees as of December 31, 1948, in the manufacture of TV transmitters pursuant to the Commission's monochrome transmission standards for TV broadcast stations."	FCC
415	Video patents owned by Radio Corporation of America and being used by RCA or its licensees as of December 31, 1948 in the manufacture of TV receivers capable of receiving transmissions of TV transmitters complying with the Commission's monochrome transmission standards for TV broadcast stations."	FCC
[fol. 196]		
416	List—"Video patents, excluding electron tubes, which RCA has the right to sub-license but does not own reported by RCA to be in use either by itself or licensees as of April 13, 1949, for the manufacture of TV transmitters pursuant to the Commission's monochrome transmission standards for TV broadcast stations."	FCC

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
417	List—"Video patents (excluding electron tubes which RCA has the right to sub-license but does not own reported by RCA to be in use either by itself or licensees as of April 13, 1949, for the manufacture of TV receivers capable of receiving transmissions from transmitters complying with the Commission's TV monochrome transmission standards."	FCC
418 <sup>13</sup>	"Commercial apparatus—license agreement between Farnsworth Television & Radio Corporation (licensor) and —"	FCC
419 <sup>14</sup>	"Television receiving set—license agreement between Farnsworth Television & Radio Corporation and —"	FCC
420	Two booklets—"Coronet presents How Much Bunk in Color Television? by John L. Springer" and "Is Color Television Ready for the Home?"	CBS
421	"Kind of Equipments Owned by Television Stations in Markets that have One and Two Stations."	RCA
422	Copy of court decision "United States v. Radio Corporation of American et al., No. 793, District Court, D. Delaware, September 15, 1942."	Dumont
423	"Description of color television receivers used in laboratory tests."	RCA
[fol. 197]		
424	Graph—"Fig. 1, Ratio of interfering signals for equal objectionability."	RCA
425	Graph—"Fig. 2, Ratio of interfering signals for discernible interference."	RCA
426	Diagram—"Color adaptor for Model 9-403M."	CBS
427	"Total RCA color broadcasting time in Washington area."	RCA
428	"Operating instructions on RCA color receivers."	RCA
429	"RCA color television programs"—Channel 4, WNBW, Washington, D. C., during week of May 1, 1950.	RCA
430	"RCA color television programs"—Channel 4, WNBW, Washington, D. C., during week of May 8, 1950.	RCA
431	Letter dated February 24, 1944, to K. S. McHugh to Niles Trammell.	RCA
432	Letter dated February 29, 1944, from K. S. McHugh to Niles Trammell with attachment (map).	RCA
433	Letter dated April 17, 1945 from Niles Trammell to K. S. McHugh.	RCA
434	Letter dated April 20, 1945, from K. S. McHugh to Niles Trammell.	RCA
435	"RCA color receiver installations in Washington area."	RCA

<sup>13</sup> Copies supplied for record. No distribution.<sup>14</sup> Copies supplied for record. No distribution.

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
436	List—"TV transmitter and receiver patents RCA has right to sublicense which were reported in use in 1949 by their respective owners."	FCC
[fol. 198]		
437	List—"Agreements by which RCA has obtained the right to sublicense FM and video patents owned by others and retain royalties."	FCC
438	List—"Video transmitter RCA licensees engaged in the manufacture of TV broadcast transmitters pursuant to Commission's monochrome transmission standards as of January 1, 1949."	FCC
439	List—"Video broadcast receiver manufacturers licensed by RCA and reported by RCA to have made sales of such receivers during February of 1949."	FCC
440	List—"As of December 31, 1948, RCA reported to FCC that it had pending infringement suits against video receiver manufacturers based on patents listed below."	FCC
441	"Service requests on RCA receivers installed in Washington area."	RCA
442	Mimeographed letter consisting of 40 sections designated 442-1 to 442-10, inclusive correcting and bringing up to date Exhibits 414-417 and 436-439; also list of manufacturers of TV receivers not licensed by RCA; list of patents asserted by RCA in pending litigation; and list of interferences with Farnsworth.	RCA
443	"Instances in which RCA has granted non-standard licenses."	RCA
444	"Supplemental exhibit on RCA service requests."	RCA
445	"Description of the CBS crispening circuit."	CBS
446	"Measurements of contrast range on monochrome TV receivers."	CBS
447	One page containing two graphs: "From Appendix of the Report of Panel #7 of the National Television System Committee November 19, 1940."	CBS
[fol. 199]		
448 <sup>15</sup>	Translation "Characteristics of the Image as the basis of Motion Pictures by R. Thun, D. K. G. of Schonelehe."	CBS
449	"Time Required to Install RCA Color Receivers in Homes in Washington Area."	RCA
450	"Cathode Ray Tube Sales."	RMA

<sup>15</sup> One copy of original article supplied for the record.

## APPENDIX B—Continued

Exhibit Number	Description	Offered by
451	"Schedule of subject matter to be shown in connection with demonstration of color television by Color Television Incorporated of San Francisco, held before the Federal Communications Commission at its hearing in the Hotel St. Francis, San Francisco, California, 17 May 1950."	CTI
452	"Pattern for Single Shift-Horizontal Shift."	CTI
453	"Pattern for Interlaced Shift."	CTI
454	"Data supplied by Color Television Incorporated (CTI) to show additional or modified components required for its line-sequential color television system."	CTI
455	"Floor Plant Arrangement for Color Television Incorporated Demonstration of 17 May 1950 at St. Francis Hotel, San Francisco, California."	CTI
456	Chart—"Television Synchronizing Waveform."	CTI
457	Diagram—"Interlaced Shift Generator."	
458	Diagram—"Horiz. Deflection and Sync Unit—Color Receiver."	CTI
459	"Field Tests Conducted by Color Television Incorporated—Description of Apparatus Used and Summary of Observations Made."	CTI
460	"Arrangement of Equipment at Color Television Incorporated, San Francisco, California for Co-Channel Interference Tests."	CTI
461 <sup>16</sup>	"Supplement to Alterations and Written Comments of Color Television, Incorporated, and Proposed Standards of Good Engineering Practice Concerning Television Broadcast Stations."	CTI
[fol. 200]		
462	Diagram—"Color Shift Circuits—Interlaced Shift Generator."	CTI
463	Diagram—"Color Drive & Tear Corrector—Interlaced Shift Generator."	CTI
464	Diagram—"Color Sync Mixer & Horiz. Drive Shift—Interlaced Shift Generator."	CTI
465	Fec Laboratory Division—Project No. 222912—May 3, 1950—"Part III—Flat Pattern Effects on RCA Color Receiver Employing High-Level Sampling."	FCC

<sup>16</sup> Filed with the Commission on March 21, 1950. No distribution.

## [fol. 201] SEPARATE VIEWS OF COMMISSIONER HYDE

I fully concur with the findings, with ¶120 to 143 inclusive of the conclusions of the majority, and with the proposal to adopt bracket standards. However, I am of the firm opinion that, based upon such findings, a final decision should be issued forthwith adopting standards for the CBS color system for the cogent reasons set forth in the mentioned conclusions with which I concur, and for the following additional reasons:

First—the fact that the operation of the CBS field sequential system with a direct view tri-color tube has not been demonstrated to the Commission, does not, in my opinion, preclude a final decision at this time. I am confident that acceptable tri-color tubes will be developed in the not too distant future and that the skill and ingenuity of the electronics industry will resolve the technical difficulties still to be overcome. Further, and in accord with the views of the majority, I believe that the normal competitive forces which would be released by the final adoption of a system at this time, would hasten the development of tri-color tubes. Moreover, the unanimous opinion of the expert witnesses representing both proponents and opponents of the CBS system, who testified on this point, was to the effect that such tri-color tubes would be usable by a field sequential system. This minimizes the “speculation and hope” referred to by the majority and makes the usability of such an ultimately developed tube by a field sequential system a virtual certainty. In addition, during the interim period required to develop an acceptable tri-color tube, color television would be available to those desiring it, through the use of disc or projection equipment.

Second—I am of the opinion that such dislocation and inconvenience as will necessarily be caused by the introduction of a color system, would be minimized by definitive action now. Such dislocation and inconvenience would be magnified by the absence of final action during the period of indecision, the length of which cannot be precisely determined at this time. Purchasers of new sets who would have had the option of obtaining color sets immediately, if they so desired, will now be forced to elect either to purchase a set which will require conversion to color, or to await final action at some future undeterminable date. Manufacturers would have been able to devote their full television research

facilities and energies towards the further improvement of one proved and accepted system meeting all of the criteria set forth in ¶122 of the conclusions, instead of dissipating them in further attempts to surmount difficulties which may be inherent in non-field sequential systems, such as those shown to exist in the systems demonstrated in this proceeding. Broadcasters would have been able to begin immediate experimentation with color programming techniques, assured of a progressively growing audience during the period of transition.

[fol. 202] Third—although I agree with the majority that the adoption of bracket standards will minimize further aggravation of the existing problem of compatibility, the majority discards too lightly the fact that the important problem of convertibility to color will be progressively worsened by each day of delay, and with each set manufactured.

Fourth—I am in full agreement with the majority's fear, as expressed in ¶148 of the conclusions, that "one of the easiest methods of defeating an incompatible system is to keep on devising new compatible systems in the hope that each new one will mean a lengthy hearing so that eventually the mere passage of time overpowers the incompatible system by the sheer weight of receivers in the hands of the public". The past history of these proceedings clearly shows that the danger feared by the majority of the possibility of unwarranted and costly delays hindering the introduction of color television is all too real. I am, therefore, of the opinion that the surest method to obviate the risk of unnecessarily delaying color would be to make a final determination at this time.

However, despite our differences as to methods to be used to achieve our aim, I am confident that all the Commissioners and the responsible members of the industry are as eager as I to terminate these proceedings with the adoption of a system meeting all of the mentioned criteria set forth in ¶122 of the conclusions, and to expedite the use and enjoyment of color television. Accordingly, I hope that the fears expressed by the majority and by me will not be realized, and that industry will cooperate with the Commission in reaching the goal by not requesting unnecessary or unwarranted delays. Such delaying tactics would receive the short shrift they merit at the hands of the full Commission, in accord with avowed views of the majority

as specifically set forth in ¶154 to 156 of the conclusions. Although, as I have heretofore stated, I am in favor of a final decision now, the Commission by majority vote has selected a different procedure for the termination of these proceedings. Accordingly, I concur especially with those conclusions which place stringent limitations on the reopening of the record and which restrict the issues and scope of the further proceedings in the event the record is reopened.

[fol. 203] SEPARATE VIEWS OF COMMISSIONER HENNOCK

I agree with the majority of the Commission that more time is desirable before making a final decision of the very difficult question confronting us in this proceeding. I also feel that in order to gain that time it is imperative that the problem posed by the great number of black and white receivers in the hands of the public which are unable to receive transmissions under the standards proposed for the most promising of the color systems we have considered, be contained at its present level. I therefore concur fully in the decision to issue a Notice of Proposed Rule Making concerning bracket standards. In the event that we do not receive sufficient assurance that this protection for future investors in television receivers will be built into sets hereafter produced, I would adopt field sequential color standards.

However, I cannot agree that in the event that bracket standards are adopted a tentative determination to adopt an incompatible color system should be made. Such a decision would, I believe, be premature. I agree with the majority that neither of the compatible systems considered in this proceeding could be authorized at the present time. Still, the improvement which took place during the course of the hearings, a relatively short time when compared to the previous course of television development, was impressive. There are many indications that intense effort is being exerted to overcome the difficulties inherent in compatible color systems. Off-the-record developments by Hazeltine, General Electric, Color Television, Inc., and R. C. A. may be bringing us a little closer, if not near, to the realization of a practical compatible color system. In any event we should work toward that end with all our energy until the last possible moment, and not foreclose the possibility of its achievement until convinced that it is a practical impossibility.

I realize that the concept of compatibility as used in this Report is not identical with that set forth in the Notice of Further Proposed Rule Making issued in this proceeding on July 11, 1949. It has, however, in my opinion become evident since that time that the effect on our present VHF television service caused by the adoption of any system which is not compatible as defined in this Report would be very serious. The problems which it would pose for the present set owner and the broadcaster should loom large in our thinking, and we should do our best to avoid them if possible.

The most direct effect of the adoption of incompatible color standards on the present set owner would be an immediate or eventual diminution of television service, or alternatively, the necessity of making an additional expenditure to maintain the usefulness of his set. To the extent that the proposed field sequential standards are utilized the present set owner would be unable to make use of his receiver. Although color broadcasts may be restricted to "fringe" time in the beginning, there must eventually come a time when there are sufficient new or adapted sets in the hands of the public that color would be broadcast during the more choice hours. At that point the present [fol. 204] set owner would be forced either to buy a new set,<sup>1</sup> adapt his present set if that is practicable, or give up virtually all television service. I feel that there is a moral obligation on this Commission to insure that valuable programming service will continue to be rendered to present set owners, both day and night, for a reasonable period, e.g., three to five years, without the necessity for making any expenditure to change their sets.

Although the record in this proceeding indicates that many sets may be adapted for \$32 to \$50, it is also clear

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<sup>1</sup> I include the possibility of converting present sets for the reception of color broadcasts in color with this alternative. The change required would be quite extensive, and there is considerable question in my mind whether this course would prove popular even with the owners of sets which could be so converted. This would be true of the compatible systems as well, but in their case only those who felt that color was worth the additional expense would have to change their receivers.

that other sets might require more expensive changes to be enabled to receive field sequential color broadcasts even in black and white. The problems posed by the necessary servicing of such installations have not been fully explored—many sets may have to be returned to the factory, sufficient properly trained service personnel may not be available, and the cost of labor for even a home installation may greatly increase the difficulty of adaptation. And it must be remembered that with all this the set owner may have an additional gadget to place on his receiver, the receiver will probably be more complicated to operate, and the geometric resolution of the picture he receives will be reduced without the compensating advantage of color. The magnitude of these problems is tremendous when it is realized that estimates indicate that almost 7 million sets were in use on August 1, 1950, and that there will be 10 million in the hands of the public by the end of the year.

Incompatibility will also pose a serious problem for the broadcaster, and its effects will very likely be felt by all television viewers. To the extent that there are receivers in the hands of the public which are unable to receive field sequential color broadcasts, every program broadcast under those standards entails a loss of audience for the broadcaster. Our broadcasting system is dependent for its economic existence upon advertising revenue, and the advertising value of a broadcast varies directly with the number of people which it can reach. The decision to produce a program in color will be a difficult one for the broadcaster to make if it means that the program will thereby become less saleable. The transition to color must, when viewed in this light, be long and difficult. With compatibility any program could be produced in color without loss of audience, and a great impetus would be provided for the purchase of new color receivers.

Color television is, I feel, a great forward step, with untold potentialities for the improvement of television for education and industry as well as entertainment. But it has been decided by this Commission that the most desirable [fols. 205-206] course to follow would be to allow more time for the development of all color systems, including the CBS field sequential system. In view of this fact, and the fact that the problems posed by incompatibility will be frozen at their present level, I feel that every encouragement should be given the development of a compatible color system. It

would be improvident, in my view, to allow only as little as three months for such a significant and difficult development to take place. I therefore feel that the date of final decision in this matter should be postponed until June 30, 1951. I do agree with my colleagues in their evaluation of the present state of the relative development of the various proposed systems so that if by that time no significant change has occurred, I would vote for the adoption of the field sequential system.

[fol. 207] SEPARATE OPINION OF COMMISSIONER JONES  
DISSENTING IN PART

I certainly join in all the findings and the conclusions up to and including paragraph 143, unanimously adopted by the Commission. These findings and conclusions establish that CBS is the superior color system and the only system ready for adoption. The reasons for my dissent from the majority's action are:

1. I dissent because there is a fundamental disagreement between the majority and myself. Stated as succinctly as possible, that fundamental disagreement between us is that I am for color *now*. Whatever the protestations or words of the majority, their action on this day is most certainly *against* color now.

2. Two systems, RCA's and CTI's, claimed at the beginning of the hearing to be fully compatible and to render a high standard of performance. They failed on both accounts throughout 9700 pages of record and in the individual and comparative demonstrations held over an eleven-month period.

3. The third system, CBS's, fully complied with the Commission's Public Notice of May 1949 and its formal proposal of July 1949 commencing these proceedings. CBS successfully demonstrated on the same record and in the individual and comparative demonstrations during the same period that it was adaptable—that satisfactory black and white pictures could be received from CBS color signals with minor modifications on existing sets at relatively minor cost.

4. The Commission unanimously finds that CBS field sequential color is superior to RCA dot sequential color and CTI line sequential color.

5. As a system, CBS now fully complies with the

criteria unanimously adopted by all seven Commissioners and described in paragraph 122.

6. The Commission unanimously has said about CBS color, and I heartily agree, that it produces a color picture that is most satisfactory from the point of view of "texture", "color fidelity" and "contrast". Receivers and station equipment are simple and easy to operate. It has found that the CBS picture "is bright enough and has sufficient contrast range to be entirely adequate for use in the home under normal viewing conditions". It has concluded that despite the fact the CBS system has less geometric resolution than standard monochrome, "the addition of color more than outweighs the loss in geometric resolution so far as ap-[fol. 208] parent definition is concerned". It has found that compared to present commercial black and white television, interference factors are substantially the same. As a matter of fact, the Commission expressly states: "On the basis of this record, the CBS color system is at least as fully developed as was the black and white system in 1941"—when standards were set for commercial black and white set operation. The obvious question naturally poses itself: Why, if these things are true, do the majority not adopt final standards for field sequential color? In assigning "reasons" for not adopting final standards for field sequential color, the majority has invented new hurdles for color to jump when the old hurdles have been overcome.

7. The majority promises that these hurdles will be cancelled in thirty days if the industry does not build bracket standards into a substantial number of black and white television receivers produced hereafter. Thus the majority abandons its power to now decide the color question on the merits—after it has found that field sequential color is superior and is ready now. It lets the television industry decide whether we will have field sequential color thirty days from now or whether we will wait until January 1951, or perhaps throw the system out completely.

8. The Commission says "if a satisfactory compatible system were available, it would certainly be desirable to adopt such a system"; that based upon a study of the history of color development over the past ten years, "from a technical point of view compati-

bility . . . . is too high a price to put on color". Nevertheless, it abandons its opportunity to finalize on the successful incompatible system in favor of a possible decision by any one in the television industry to try any other color system.

9. In view of the consistent record of the industry thwarting color for ten years,<sup>1</sup> the Commission gambles with the only proponent who has advanced a successful system of color television these ten long years. Although the majority claims that the status quo will be maintained by a promise of the industry to build bracket standards into a substantial number of new black and white receivers, color still is not being fostered commercially and only black and white is being fostered. The majority says "one of the easiest methods of defeating an incompatible system is to keep on devising new compatible systems in the hope that each new one will mean a lengthy hearing so the eventually the mere passage of time overpowers the incompatible systems". In its attempt to relieve the compatibility problem, during the period of more delay, the majority overlooks the fact that because the percentage of sets capable of receiving CBS color signals in black and white goes up, color is not promoted one iota.

10. The majority decides: A demonstration of the direct-view tri-color tube with the CBS system is *unnecessary* if a substantial percentage of black and white receivers hereafter produced do not contain bracket standards. If such sets do contain bracket standards, the majority avoids finalization because it wants such a tube demonstrated.

11. The majority decides more information on horizontal interlace is unnecessary if a substantial percentage of black and white receivers hereafter produced do not contain bracket standards. If they do, the majority again avoids finalization because, it says, it wants to know more about horizontal interlace. But it has found that the apparent definition of CBS color pictures is already satisfactory without horizontal interlace. So why wait?

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<sup>1</sup> See the Annex to this opinion.

12. The majority decides that it need not further consider the development of long persistence phosphors if a substantial percentage of black and white receivers hereafter produced do not contain bracket standards. If they do, the majority again avoids finalization because it wants to know more about long persistence phosphors. The Commission, however, as a part of this decision would force the industry to adopt bracket standards in black and white receivers without requiring any further proof or field testing of long persistence phosphors. Why, therefore, shouldn't we treat color in the same way?

13. We either need more information concerning direct-view tri-phosphor color tubes, long persistence phosphors and horizontal interlace, or we do not, irrespective of what the industry position is. Since the Commission will finalize CBS color if the majority of the manufacturers refuse to build bracket standards in a substantial majority of black and white sets hereafter produced, then it necessarily follows that the findings of fact amply support such action right now.

14. I agree with the majority that we ought to propose the adoption of bracket standards. I do not, however, believe that consideration of these standards should be permitted to delay a final color decision.

[fol. 210] 15. Had the Government thrown its weight against the public's desire to buy and play with crystal sets, against receivers with morning glory loud speakers and howling signals, on the theory that radio should not be commercialized until super-heterodyne and FM were invented, the tycoons of television would be dwarfs today and the radio industry would be but a feeble voice in America. Today we have a color system that has long since passed the howling speaker and crystal set stage. All of the Commissioners have agreed that the field sequential system is as good as black and white was in 1941 when commercial standards were set. Every proceeding must come to an end sometime. The Commission has tested the opinions of the whole industry in the crucible of exhaustive public hearings. It has determined those positions that have been unsound, lacking in imagination, and based upon fear of competition of color with black and

white television. The impurities of engineering and economic thought have been burned out by the findings and conclusions to which I adhere. The industry should examine carefully the refined ore so that it may align itself with the public interest. The Commission, on the other hand, should by final decision now cut the Gordian knot which has bound color television for ten years.

[fol. 211]

## ANNEX

### I

The following is a study of the disgraceful treatment of the field sequential system by the industry from 1940 to date.

In all the history of the Commission, never have such exhaustive and comprehensive hearings been held in all facets of a service about to be launched. The sequential and simultaneous color systems have been discussed in industry committees since 1940.<sup>1</sup> The field sequential color system had been explored in 300 hours of actual broadcasts on the air in a 6 mc VHF band by early 1942. By December 11, 1946, 16 mc color television had been field tested for a period of 2½ years (Docket 7896, p. 373) cumulating over 2000 hours of filed sequential color broadcasting on the air. The simultaneous color system never has had successful on-the-air broadcasts, as will be more fully discussed hereinafter. However, on the 18th day of March, 1947, field sequential color was rejected on several specific grounds. These specific grounds inferentially disclose that the Commission accepted the almost universal industry testimony

<sup>1</sup> "In 1940 there was submitted to Panel No. 1 of the National Television Systems Committee the following description of a system requiring simultaneous standards:

"Three-channel, three-color additive system consisting essentially of an independent chain of equipment (RMA standards) for each of the three colors, including a separate kinescope of proper screen color for each, with optical combination of the three images . . . partially complete system tested in laboratory, and demonstrated to FCC, February, 1940." (Murphy, Docket 7896, pp. 64-65)

that the simultaneous system was the only system that should be considered by the Commission as worthy for commercial color broadcasting. Today, we know that the simultaneous system never had a successful on-the-air broadcast, as will be more fully discussed hereinafter. The vain hope for a color system better than field sequential color may explain why some of the grounds were unsound from an engineering standpoint. The unsoundness of some of these grounds denying color in 1947 has been proven in this 1949-50 hearing record. Other grounds show the 1947 Commission lacked imagination to encourage this new use of the radio art. It is my understanding that certain Commissioners were sympathetic, but their sentiments do not appear in the final decision. In any event, the sound nature of the field sequential color system and its great potentialities for engineering improvement were certainly not appreciated by either the industry or a majority of the Commission in 1947.

[fol. 212] For the purpose of appraising the Commission's 1947 decision and its lack of imagination, and the unsound engineering principles upon which that decision was based, it is necessary to discuss the background in which the decision was written. By background I mean the bases upon which engineering judgments have been made by industry witnesses in their testimony before the Commission. That involves the good faith if not truth and veracity of the witnesses for the industry, and the industry committees—especially the NTSC and the RMA. The beginning of the history is in 1940. In the first place, the FCC wanted color to be introduced at the same time that black and white television was considered. The Chairman of the FCC urged the industry to formulate standards for color as well as black and white. In addressing the first meeting of the National Television System Committee on July 31, 1940, Chairman Fly said to the industry:

“If you want to say that color must come together with television and move forward and give us a complete television system at the outset, anyone would hope that such result could be made.” (Proceedings of NTSC, Docket 5806)

In the face of these strong representations by the Chairman of the Commission, the NTSC was organized and Dr.

Baker was made chairman. The Committee organized itself into nine panels; Panel 1 was charged with reporting television systems to the main Committee. Field sequential color was demonstrated at that time in the laboratory as a possible system to be adopted at that time. Dr. Baker made a special trip to a meeting of Panel 1 to discuss color television with the panel. Deleted portions of the official minutes of Panel 1 show Dr. Baker's, and the industry's, attitude toward the introduction of color at the same time as black and white. Following are some of the significant statements of Dr. Baker that were deleted:

"But I don't see from the viewpoint of the GE Company how we can afford to complicate the black and white system by introducing on top of that, color." (Tr., p. 9741)

"If this thing [color] came to NTSC I would strongly oppose color for the reason that it is not old enough . . ." (Tr. p. 9745)

"Frankly, if it came up to the NTSC, I would oppose it due to my ignorance of it." (Tr. p. 9746)

"You know the NTSC does not presume to even make a decision except based on the evidence you submit, that is, which the panels submit. They are expecting you will turn down color television." (Tr. p. 9747)

Clearly, then, as far back as 1940, Dr. W. R. G. Baker, Chairman of the NTSC, had already made clear to the [fol. 213] NTSC that the industry did not want color and black and white television to be introduced at the same time.

In view of the official interest of the FCC in color, as expressed by the Chairman, it is significant that these portions of the minutes of the NTSC were deleted. It is regretted that the economic sentiments of the guiding engineering genius of Dr. Baker were not conveyed to the FCC at the time. For it is apparent that the Commission, at the hearings preceding the organization of NTSC, had been particularly anxious that no standards be set which would freeze the art to the RMA conception of black and white television. It had held extensive hearings on whether black and white should have 441 lines and 30 frames, as recommended by the RMA, or whether they should allow a flexible number of lines and frames, from 400 to 800 lines and from 30 to 15 frames. It is reasonable to assume that

if the Commission had held extensive hearings for the specific purpose of making sure that it was not freezing black and white television to the RMA concept in the industry's private interest, it certainly would not have permitted NTSC likewise to exclude the art of color television for those same purposes of private interest. This is demonstrated by the following questions asked by Chairman Fly and Commissioner Walker in trying to insure that the industry was not delaying color television:

"Chairman Fly: Doctor, this is the only committee that deals with color television?"

"Dr. Goldmark: Well, some of the other panels have also color television but in a very general sense. We were charge with making a more thorough investigation. I think the other panels, as you will probably hear later, made statements as to the broad policy.

"Chairman Fly: I am wondering about the future technical advance of color television and to what degree there is cooperation in the industry in moving color television forward. Are you making your information and your resources in general available to engineers of the other companies?"

"Dr. Goldmark: Upon request, yes.

"Chairman Fly: And, are any of the other companies undertaking to move any phases of it forward?"

"Dr. Goldmark: There are two or three companies which definitely are interested and took steps to obtain information from us regarding color; in addition we gave papers on every phase of color television to the whole industry keeping back nothing.

"Chairman Fly: And as I understand, you and the Columbia Broadcasting System will cooperate with any of the companies that wants to undertake to—beginning [fol. 214] at this point—further develop color television so as to move toward bringing it into the scope of practical operation?"

"Dr. Goldmark: Absolutely.

"Commissioner Walker: It isn't tied up with patents?"

"Dr. Goldmark: Not on our part. We have patent applications but that is no concern of ours. The primary purpose, in other words, is to get cooperation and our primary interest is color television per se, whether it is ours or somebody else's it makes no difference.

"Commissioner Walker: You are not trying to restrict it by patents?"

"Dr. Goldmark: Oh, no." (Docket 7896, pp. 2311-13)

These events all occurred in the following background: The membership of the NTSC had viewed laboratory demonstrations of the field sequential color system and had overwhelmingly approved of the color pictures produced by CBS. These votes were duly recorded in their minutes. Specifically, by a vote of 30 to 4 they preferred color television as demonstrated by CBS<sup>2</sup> to black and white. By a vote of 34 to 2 they said the addition of color increased the entertainment value of televised pictures. By a vote of 32 to 3 they thought the color quality of such color pictures would be acceptable to the public. By a vote of 31 to 7 they thought color adds to the apparent resolution of a black and white picture. By a vote of 20 to 12 they thought the apparent resolution of color as demonstrated was satisfactory. By a vote of 33 to 4 they thought that the brightness of the color picture demonstrated was acceptable. By a vote of 34 to 3 they did not believe that all commercial receivers should be able to receive color television as well as black and white. By a vote of 20 to 16 they did not believe that commercial black and white television receivers should be able to receive color transmissions in black and white. By a vote of 24 to 11 they decided that color transmissions should be allowed in Group A channels.<sup>3</sup> See proceedings of Panel 1, NTSC, Docket 5806.

One can readily conclude: Every reaction to color performance in 1940 to 1941 by this collection of eminent engineers was positive; but the test votes on establishing color [fol. 215] were negative. Panels 1, 6, 7 and 8 voted 25 to 16 that transmission standards for color television should not then be *considered*. This latter vote was apparently not based upon constructive engineering grounds, for many of the engineering problems that had confronted the adoption of black and white television were common to color. Settling these for black and white television, they would

<sup>2</sup> It will be noted that the system they were judging was a 6 megacycle field sequential system.

<sup>3</sup> Group A channels consisted of seven channels between 50 to 108 mc.

have settled them for color. I refer to such problems as the modulation of the picture carrier, the modulation of the voice carrier, the distance between the voice and sound carriers in a 6 mc channel. The propagation characteristics of color as a separate problem from black and white was not raised. Likewise, neither were separate problems raised for color regarding co-channel and adjacent channel signal interference ratios. The unexpurgated record of the proceedings of the NTSC, disclosed formally in this hearing for the first time, after nearly ten years, demonstrates that recommendations of color standards for immediate adoption were deferred in accordance with Dr. Baker's instructions to Panel 1, NTSC, quoted above.

It may be said without contradiction that considerations for delay of color were based upon alleged ignorance of the industry and purely economic considerations concerning the impact of beautiful color television pictures upon black and white television pictures. More specifically, the manufacturers' considerations were: the effect of the sale of color receivers upon the sale of black and white receivers.

Convincing evidence that Dr. Baker's colloquy with Panel 1 of NTSC in September, 1940, expunged from NTSC official records, had great weight upon the manufacturing industry's engineering talent is buttressed by the television industry scientists' testimony in the 1946-47 color proceedings.

Some of the manufacturing industry back in 1940 supported color; later they joined the black and white bandwagon. Du Mont is an example of this.

Du Mont in 1940 had recommended 800 lines and 15 frames for black and white television standards. Nearly the entire industry through RMA recommended 441 lines and 30 frames. Du Mont had fought the entire industry with the proposition that its 800 line standards and the RMA's 441 lines standard could be adopted by utilizing circuits in receiver design which would operate on any number of lines and frames between the two proposals. It used the different number of lines and frames conceived

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\* Du Mont originally proposed 625 line standards on the basis of higher definition black and white pictures. It hoped to have flexible standards adopted which would provide 800 lines in the future.

then for field sequential color as an argument in support of its flexible standards. For, as Du Mont engineers argued, as higher definition in black and white television could be had with 800 lines so color could be introduced at any time because the flexible receivers would respond to the different number of lines and frames of field sequential color. Since the NTSC decided against proposing color standards in [fol. 216] 1941 and rejected Du Mont's 800 line-15 frame suggested standards for black and white television, Du Mont from that time on took the industry position that color was never ready for commercialization.

Proof that Du Mont was attributing an alleged engineering reason merely to support the manufacturing industry's economic position on color as expressed by Dr. Baker in 1940 may be seen as the Du Mont testimony in Commission proceedings unfolds. In the 1947 color hearings Dr. Du Mont said:

"PROPAGATION. At the present time the frequencies between 480 and 920 megacycles have been assigned for experimental television use and it is proposed to use this band for color television.

"Several years ago at the hearing on the allocation of frequencies fears were expressed by a number of the parties involved that, while this band was satisfactory for relay purposes where sites could be selected, it would not be suitable for broadcasting where the receiving location could not be chosen. Our experience since that time, while not as extensive as we would like, leads us to believe that these frequencies are not suitable for broadcasting use except in certain instances involving fortunate geographical locations. The details of the tests we have made in this connection will be discussed by T. T. Goldsmith, Jr." (Docket 7896, pp. 1406-7)

But by 1948<sup>o</sup> Du Mont was confident that the UHF could be used for black and white:

"The Chairman: Mr. Goldsmith, you are advocating that we now have enough information to go ahead and allocate this band for black and white?

"The Witness: Yes.

"The Chairman: 475 to 890?

"The Witness: Yes." (Tr. 168)

Du Mont engineers did not claim they had made further propagation tests in the UHF, nor that they had developed equipments, particularly tubes, to more effectively utilize the UHF. In fact, T. T. Goldsmith for Du Mont now recommended the use of UHF solely and specifically to prevent chaos which might result from channel loading black and white television in the VHF. He offered *no engineering* testimony in his support when the Chairman reminded him that JTAC and RMA still claimed they didn't have enough information for its utilization.

"The Chairman: Your recommendations imply that you think we have sufficient information. The J.T.A.C. says we haven't, that we need more information on points A, B, C, D, E, and F:

[fol. 217] "The Witness: Mr. Chairman, I feel that it would be highly desirable to get a lot more information on this subject, but, on the other hand, it is a matter of considering the lesser of the two evils, as I look at it. We have been establishing a nationwide television service, already going, at the rate of millions of dollars worth of business, with the public making tremendous investments. The allocation plan is spread thickly as now proposed in the VHF and will result in an awful lot of chaos. You can't hold those other people back for a few years and say 'We will see what we can do about it, we will build fences around the cities, and so forth.' There doesn't seem to be a real answer to it, to the scarcity, other than getting additional channels.

"The second question is, where can you get those? We have studied very thoroughly the possibility of getting sufficient channels down low and it doesn't seem feasible at all to get enough to give a real competitive service and to satisfy the demand of those people willing to invest their money. We look to the regions of the F.C.C. set aside for future television. We say, is it useful? What about it? Well, there are lots of questions in that region. We don't know the exact answers. My feeling is that we can give enough safety margin on those factors which are still rather uncertain." (Tr. 168-9)

To complete the record that the Du Mont company wanted to utilize the UHF exclusively for black and white television, T. T. Goldsmith urged now that color television be committed to the uncharted<sup>5</sup> microwave band of frequencies. There were no proponents of color in the September 1948 hearings, although CBS disclosed their 6 megacycle sequential color system to JTAC (Exhibit 1), but the Du Mont company was apparently making a record for further postponement if color television should rear its ugly head again. Dr. Goldsmith testified further:

"Commissioner Walker: When you say 'open it up to immediate commercial use', you mean the monochrome system that you are using now?

"The Witness: That is right, Commissioner Walker.

"Commissioner Walker: Were you one of the parties that advised us to reserve these ultra high frequencies for color television?

[fol. 218] "The Witness: Yes. I think it was a wise plan to reserve them for experimentation for all kinds of television systems. I would like to have it for color if we could do it, but I do not believe it is the wise thing to kill the black-and-white possibilities.

"Commissioner Walker: What becomes of television after you have used all of these up for black and white?

"The Witness: The color system, if developed, might ultimately replace the black and white in this same frequency range if it can be proven to be far superior, but I believe the color system if developed can probably use some microwave frequencies for its broadcasting." (Tr. 190-191)

Later Dr. Goldsmith said:

"I don't like microwave for color. I like color television and I would like to see color television service on something other than microwave, but when you add all of the facts up, I don't see any other way out." (Tr. 224)

In 1950, Dr. Du Mont made clear the type of interest that motivated him to contend that the UHF was ready for

<sup>5</sup> The microwave even today has not yet been used or field tested in any manner whatsoever for broadcast purposes.

immediate standardization. Thus he testified that the longer the freeze stayed on the more difficult it was for him to expand his network:

"The Witness: We lost that program because we have not been able to get affiliates with respect to these stations. This hold-up in the hearing down here is creating a very nice little monopoly.

"I did not say my presence here. I said the fact that the freeze has been on for 13 months—certain people in the industry have been in the business a long time and they have ample affiliates, and they are able to offer more stations on the network than we can. Until such time as the freeze is over that condition is going to continue." (Tr. 5723)

The industry and industry committees have paralleled the Du Mont company position with reference to saving the UHF for black and white television ever since 1941 when Du Mont fell in line with the industry after the defeat of its flexible standards proposal. The only deviation between them since then is that Du Mont in September 1948 recommended utilization of the UHF for black and white television because it foresaw the crowding of the VHF channels a year earlier than the rest of the industry. Significantly, when in 1946 Columbia wished to introduce color on the UHF band, the RTPB made no recommendation to use the UHF. They clearly did not want any [fol. 219] propagation data that would assist the commercialization of color in the UHF at that time. David B. Smith, testifying for the RTPB, said:

"Q. You do not feel that RTPB came to final conclusions as to the thorough adequacy of the UHF channels for television broadcast service, do you?

"A. Well, from a propagation standpoint, we did nothing. ~~We just did not~~ consider any allocation problems or any propagation problems." (Docket 7896, p. 681)

In 1948 when the Commission invited proposals for utilization of the UHF, the industry committee, at that time known as JTAC, took the position, as has been previously

indicated, that black and white did not need the UHF for expansion, and it claimed that there was insufficient information to establish commercial service in the UHF:

"In summary, the JTAC finds that additional information on the following topics is required before service areas and interference areas may be predicted with reasonable accuracy:

A) Noise figures of commercially realizable UHF television receivers.

B) Signal/noise ratio, at the viewing screen, giving acceptable service at various bandwidths and for several different systems.

C) Measurements of factors governing normal propagation at frequencies between 475 and 890 megacycles over a variety of types of terrain.

D) Measurements of barely perceptible and objectionable interference ratios (visual and aural) at various bandwidths and for various systems.

E) Selectivity characteristics of commercially realizable UHF television receivers.

F) Measurement of tropospheric factors governing abnormal propagation at various frequencies in the 475-890 megacycle band over a variety of types of terrain and atmospheric conditions.

"All of the above factors are in the Class C (speculation) category at present. Together they constitute a preponderance of the technical information necessary to an allocation plan. Hence, any attempt to formulate an allocations plan, based on present knowledge of these factors, would be without sound engineering foundation." (p. 30-31, Exhibit 1)

[fol. 220] This industry committee left no doubt that it meant for the commercialization of color to be postponed to the indefinite future, although since 1941 there had been a practical color system that had been field tested.<sup>6</sup> JTAC said:

<sup>6</sup> See page 1, supra, for number of hours of field tests of field sequential system; see page 43, infra, for field tests of the simultaneous system.

"The JTAC is of the opinion, based on evidence submitted to it by various subcommittees of the RMA and IRE, that it is impracticable to set up commercial standards for color television in the present state of the art.

"Bandwidths cited to the JTAC as applying to wideband experimental color television systems are as follows:

CBS sequential system: 144 fields—525 lines—12 megacycles

RCA simultaneous system: 60 fields—525 lines—14 megacycles

If it appears advisable to assign 6-megacycle channels to an interim monochrome service on the ultra-high frequencies, two alternatives may be considered to provide for a later conversion to color service. One is to assign the 6-megacycle channels at intervals, interposing an unused space of 6 or 8 megacycles between channels. This would permit the later expansion of each monochrome assignment to a color system assignment having a bandwidth of 12 or 14 megacycles. The second alternative is to assign adjacent 6-megacycle or 7-megacycle channels, with the understanding that half of these assignments would be deleted when conversion to color service takes place." (pp. 34-6, Exhibit 1)

It cannot be said that in 1948 JTAC had any thought for utilizing the UHF for color. In fact, they expressly indicated that use of the UHF for black and white would keep color out of that part of the spectrum. The Report said:

"In view of these facts, the JTAC comes to the conclusion that it will be difficult, both in theory and practice, to provide for a conversation from uhf monochrome assignments to uhf color assignments. The JTAC believes, therefore, that any assignment of monochrome service to uhf channels would represent a permanent removal of the space so occupied from

that available for any other service." (p. 36, Exhibit 1)

[fol. 221] This statement is all the more significant since the existence of 6 mc field sequential color was reported to the JTAC in a letter from Columbia Broadcasting System dated August 16, 1948, included in the same exhibit. (p. 131, Exhibit 1)

It is also significant to note that no JTAC member was interested enough in 6 mc color (the simultaneous system by this time had been abandoned by RCA) to view the performance or review the characteristics with the inventor.

The JTAC and RMA didn't feel the inadequacy of the channels in the VHF until a year after Du Mont foresaw it. In 1949 when the Commission had invited proposals for color television in the 6-mc channel in the 12 VHF and 43 channels of the UHF, JTAC recommended utilization of the UHF.

While not stating specifically that it believed there was now enough information upon which to base the opening up of the UHF, it pointed out the importance of getting stations into the UHF and recommended that the monochrome VHF and UHF allocations be made before color was considered. It then set up a long and arduous program for the color question, all of which was to come after the black and white problems had been disposed of by the Commission.

*"8. Recommended procedure prior to adoption of a color system. JTAC recommends that the following steps be taken prior to the final adoption of standards for a color service:*

*Step 1. Establish the allocation for monochrome service on the vhf and uhf bands, in accordance with the present proposal, suitably extended or modified as may appear in the public interest as a result of the evidence taken at this hearing.*

*Step 2. Determine whether or not a suitable compatible or adaptable 6-mc color system exists which may be superimposed on the existing monochrome channel structure. In this determination, the performance and technical advantages, as well as the effect on the existing monochrome structure, of the several*

6-mc color systems should be compared. The cost to the public and the extent of use of adaptable and compatible systems should be assessed.

*Step 3.* When and if it is determined by the Commission that such a compatible or adaptable 6-mc color system, of suitably high performance and suitably low cost, exists, notice should be given of the intention to adopt such a system, and full particulars of the system promulgated to the industry.

*Step 4.* Prior to such notice, a stated interval of time should be reserved during which proponents of the alternative systems may have the opportunity to demonstrate the comparative performance and costs of such alternatives:

[fol. 222] *Step 5.* Following the determination to standardize on a particular color system, and prior to the final adoption of standards for commercial use, a public field test of at least six months duration should be undertaken to assure that the proposed service can, in fact, be rendered.

*Step 6.* If it is determined that a compatible or adaptable color system of suitably high performance and low cost does not exist, or if it is determined that it is against the public interest to institute a color service on 6-mc channels, provision for the development of a color service in a region of the spectrum not occupied by the monochrome channels should be made, and a specific reservation of spectrum space for such a service should be made." (pp. 18-20, Exhibit 203)

Although there are many examples showing that the industry has feared the adoption of color television in the same bands with black and white, and that it also has opposed opening up the UHF for color television, the positions of the industry committees and the Du Mont company serve to show on the record that the industry wants black and white television to operate to its full bloom on a national scale in every channel available as the demand grows before color is introduced. We thus find that the Commission decision of March 18, 1947, relied almost entirely upon the evidence submitted by an industry whose motive over a seven year period of time was to delay color.

It is now appropriate to summarize the activity of the industry during this seven year period with field sequential color.

The 1941 decision of the Commission adopted standards for black and white television in the 18 VHF channels. As a part of that decision the Commission had formally urged immediate field testing of color television, and the number of 375 lines and 120 frames were formalized in the Standards of Good Engineering Practice for field testing field sequential color. By 1947 the industry<sup>7</sup> had done nothing substantial in color television to carry out the Commission's formal order or the NTSC's promise of further field testing of color broadcasting. In the 1950 hearing record, the industry again explains that war demands hindered such field tests. It further explains that a period of 18 months after the cessation of organized hostilities, August 1945, was required for reconstruction and rehabilitation of their scientific personnel and physical plant for peacetime research and production. Although Columbia's scientific and laboratory staff was likewise engaged in the war effort, by 1947 Columbia was still the only active proponent of color television immediately. By 1947 CBS had already done more field testing in the UHF than any other company. It had constructed studio and receiving equipment for its system in this band. In addition, it assumed the burden of collecting propagation data in the UHF.

[fol. 223] In the 1946-47 hearing record on Columbia's Petition to adopt field sequential color, RCA industry members testified in support of the RCA and RTPB positions to foreclose color as an immediate competitor of black and white television. Thus RCA made known that it did not want color television introduced concurrently with black and white television. Dr. Jolliffe stated:

"At the outset I would like to summarize our position:

"First: We have today a well developed monochrome television service. All of the equipment—transmitting and receiving—has been engineered to the point where it is capable of excellent reproduction in the home of the best in current events, sports, drama and education. We urge the Commission to give full

<sup>7</sup> Except the Columbia Broadcasting System.

support to this proven service and continue to encourage its fullest use for the benefit of the public.

"Second: No steps should be taken under the guise of bringing color television to the public which, instead of advancing the art of television, confuse the public, the broadcaster and the equipment manufacturer and result in depriving the public of any television service now and for some time to come." (Docket 7896, pp. 646-7)

B. Ray Cummings, Vice President of Farnsworth Television & Radio Corporation, said:

"We would say, in conclusion, that:

1. An excellent system of monochrome television is now available and its acceptance and widespread use leading to an economically sound system of broadcasting should not be jeopardized;

2. That there is substantially sufficient evidence, based on the motion picture industry, that monochrome pictures can give entirely satisfactory programs for an indefinite period. There appears, therefore, to be no need for undue haste for the adoption of a color system;

3. Adequate time must be taken in exploring alternative color television systems to insure that the one selected will be most suitable;

4. It is our understanding that the industry as a whole is making a tremendous investment of money and effort at this time to insure the success of the monochrome system. Any dilution of this effort at this time to also include the production of color television apparatus would substantially detract from the prospects for monochrome television." (Docket 7896, pp. 618-20)

We are now in a position to examine the 1946-47 engineering testimony of the industry with respect to field sequential color. The 1949-50 hearing makes crystal clear that the industry's engineers were unsound analysts not only of the field sequential system but also the simultaneous system. Their engineering testimony in 1946-47 is rendered so completely worthless by the 1949-50 record [fol. 224] that the kindest thing that can be said in explana-

tion is that their economic interest blinded their engineering judgment. In view of the position taken in both hearings by witnesses who testified in support of the simultaneous system (which was a complete failure) there is grave doubt that any can be relied upon to predict the potential performance of any system whose adoption might prejudice their economic interests.

In the pages that follow we will discuss the specific engineering questions that were involved in the 1947 decision. The evidence adduced in that record and in the current record show that the CBS system was rejected *as a system* on unsound engineering grounds and that the Commission lacked imagination to encourage the art of color television because it relied upon witnesses hostile to color.

[fol. 225]

### The Mechanical Myth

The most important error of the Commission's 1947 color decision was the implicit assumption that the field sequential system could only be regarded as a mechanical system. The Commission stated:

*"At the hearing, Dr. Goldmark testified that the color wheel was not an integral part of the sequential system. In his opinion, color can be produced under a sequential system by employing three different tubes each one coated with a special slow decay phosphor that is sensitive to only one of the three primary colors. The difficulty with the use of such tubes has already been adverted to. In the first place, no such system has yet been built or field tested. Secondly, witnesses for Du Mont testified that the company had made tests with slow decay phosphor tubes but had found them objectionable. Unless or until a system which has the 3-tube system is constructed and field tested, there is no assurance that it will work successfully. The Commission, therefore, cannot assume with any degree of assurance that the Columbia system is not limited to the color wheel with the severe restrictions it imposes on picture size in a direct viewing receiver."* (Emphasis supplied) (11 FCC 1533).